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Research Article

Critical Review of Research Methods Used to Consider the Impact of Human–Animal Interaction on Older Adults' Health

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Abstract

Background and Objectives: Most research on human-animal interaction (HAI) and human health focuses on one of three perspectives: (a) health effects of pet ownership; (b) health effects of contact with a companion animal; or (c) health effects of animal-assisted interventions including animal-assisted therapies, and animal-assisted activities.

Methods: We reviewed research methods used to address each perspective, within the context of human aging, and identified challenges associated with these methods.

Results: The complex challenges involved in designing studies to address all three perspectives and examples of research design elements that can be used to alleviate issues raised in each type of study are provided.

Discussion and Implications: We suggest emerging methodologies that may be helpful for answering important questions from all three perspectives about the relationship of HAI to health outcomes for older adults.

Keywords: Human–animal Interaction, Methodology, Stress & coping (anxiety & agitation), Quality of life, Epidemiology

Introduction

Most research on human–animal interaction (HAI) and human health focuses on one of three perspectives: (a) health effects of pet ownership; (b) health effects of contact with a companion animal; or (c) health effects of animal-assisted interventions (AAI) including animal-assisted therapies (AAT), and animal-assisted activities (AAA). We examine the research methods and the associated challenges of each perspective separately, since these factors vary with the nature of each approach. We also describe emerging methodologies that may be helpful for addressing questions within each of these perspectives.

Pet Ownership

Most studies of the health effects of pet ownership rely on cross-sectional observational studies comparing people who own pets with people who do not (Barker, Rasmussen, & Best, 2003). Cross-sectional observational studies of the relationship between pet owner and health range from studies using convenience samples or small groups to studies involving nationally representative samples/surveys (Parslow, Jorm, Christensen, Rodgers, & Jacomb, 2005). All involve individuals who are asked questions about their pet owner status and about a variety of health-related outcomes. Some studies also include biomarkers from the entire sample or a subgroup. (For a review of specific studies supporting this paper, see Gee & Mueller (2018).) Generally, because cross-sectional studies obtain data from each person only once, they give information about perceived health or actual health at one time point. They provide useful information about association but lack the temporal component to add a causative element. Nevertheless, they are important

for justifying the need for additional studies to investigate a potential causal role of pet owner (in combination with other characteristics) in promoting successful aging.

Longitudinal observational studies of a cohort of individuals followed for some period of time comparing changes in outcomes among pet owners as compared with changes among nonowners provide somewhat stronger evidence for causality. A few longitudinal studies of healthy individuals support the contributions of dog walking to exercise among older adults (Thorpe, Jr. et al., 2006) and of adopting a pet to health (Serpell, 1991).

The one randomized single blind study of giving pets to older adults involved giving crickets as pets to relatively health Korea community living older adults. After 8 weeks, the new pet owners improved their depression, cognitive status, and mental health quality of life more than a comparison education only group; there were no differences in changes in biological indicators of stress during the same period (Ko, Youn, Kim, & Kim, 2016). Longer term follow-up would be needed to discover whether this is a novelty effect or a sustained impact of pet ownership.

Challenges in Studies of Pet Ownership and Successful Aging

Specifying Health Outcomes

As with all studies of health outcomes, a major challenge in pet owner and aging research is deciding on the outcome and how it will be measured. Theoretical bases of a hypothesized relationship are crucial for determining what health outcomes pet owner might impact. The biopsychosocial model provides a framework for understanding the role of pet owner or HAI within the context of healthy aging, as it emphasizes the interactive nature of the biological, psychological, and social realms (Lindau, Laumann, Levinson, & Waite, 2003). Disruptions or enhancements in any realm impact the others and together they influence health. Pet owner, as a component of the social realm of the model, should decrease depression and loneliness, enhance social support and social interaction, decrease anxiety and stress, enhance feelings of safety and calmness, and promote exercise. These psychological and social effects impact physiological responses which in turn promote wellness and health.

For studies of the contribution of pet owner, successful aging health outcomes might include cognitive status, physical fitness, mobility, age at which assistance is required for daily living, number and type of chronic diseases, age of onset of symptoms, health-related quality of life, depression, social isolation or loneliness, and other psychological indicators, as well as mortality. More distal measures of health status might include health care costs, number of hospitalizations, and number of health care appointments. Even within each outcome there may be a variety of meaningful measures, and pet owner may predict changes in some but not all aspects of the outcome. All-cause mortality is the easiest outcome to define and thus the gold standard for clinical trial research. Other outcomes such as morbidity, quality of life, and functional status may be more relevant when examining successful aging but are more challenging to quantify.

Longitudinal studies of individuals with cardiovascular disease illustrate this challenge. Three studies examining the contribution of pet owner to survival in patients who had experienced hospitalization for coronary heart disease to survival demonstrated an association of pet owner with survival (Friedmann, Katcher, Lynch, & Thomas, 1980; Friedmann & Thomas, 1995; Friedmann, Thomas, & Son, 2011). A large Australian study of older adults treated for hypertension showed lower cardiovascular mortality and a tendency for decreased all-cause mortality among both current pet owners and individuals who had owned a pet at some time in their lives (Chowdhury et al., 2017). In contrast, a study using the composite end point of mortality or hospitalization found no association between pet owner and this composite outcome (Parker et al., 2010). This discrepancy in findings suggests that the role of pet ownership as a predictor of hospitalization differs from its role in prediction of mortality.

Limitations of Studies

Both cross-sectional and longitudinal observational studies suffer from several limitations, especially when studying small cohorts. Observational studies often suffer from selection biases. Individuals who agree to participate in a study may be more or less healthy, have differing social interaction needs, or have different personalities than those who refuse participation. Studies may under-represent minority groups, recent immigrants, and others who wish to avoid study personnel or individuals they perceive as authority figures (Napoles-Springer et al., 2000; Wallerstein & Duran, 2006). Additionally, most research is conducted in English only which may restrict participation (Hazuda, 1996).

Finally, the potential independent contribution of pet ownership cannot be ascertained unless covariates and confounding variables, rarely obtained in studies, also are included in analyses. Including these additional variables increases the required sample size, making these studies costly (Thorpe, Jr. & Kelly-Moore, 2018).

Defining Pet Ownership and Pets

Defining pet ownership is one of the biggest challenges for conducting all studies of pet ownership and health outcomes. By some definitions all people who live in a household with a pet are considered pet owners, while other definitions restrict pet ownership to having care-taking responsibility for a pet. To further complicate matters, definitions of a pet may differ across cultures. For example, in a farm environment, several cats may live in barns and outbuildings while others are house-cats; different respondents may consider none, some, or all of these of these animals to be pets. Currently, we largely rely on respondents self-defining as pet owners or nonpet owners, which may

introduce error or noise into the data. A more fine-tuned approach might provide valuable insight.

Since people often keep multiple species of pets, depending on study aims the way specific animal ownership is defined can have implications for the research. Should someone who keeps cats and dogs be defined as a cat owner, a dog owner, or an owner of multiple species? Specific fitness and functional benefits of pets are attributed to the physical activity/demands associated with ownership of those pets, commonly exemplified by comparing walking the dog to the responsibilities entailed in ownership of other common pets such as cats, birds, and fish. In these instances, dog owners are defined as all people who own dogs, no matter what other animals they also own, although even among dog owners there is considerable variety in the type and amount of exercise owners experience.

Other aspects of pet ownership that are of interest to study in relationship to healthy aging include the history and length of pet ownership. Even if an individual is not currently a pet owner, some effect of prior pet ownership may carry over and the time course of such lingering effects would require investigation. Research on human development suggests effects of pet ownership in early life on development of social skills and emotional development (Daly & Suggs, 2010; McCune et al., 2014) as well as development of or resistance to allergies. If these qualities are related to health outcomes in later life, even pet ownership during childhood might impact differing health outcomes.

A related question is whether one needs to actually own a pet to enjoy benefits associated with pet ownership. This question is addressed in some intervention studies discussed later in this paper and explored in more detail by Gee & Mueller (2018). Still, the contribution to health of a close relationship/interaction with someone else's pet has not been evaluated in community life nor has the presence of resident animals in long-term care facilities, both of which scenarios avoid the responsibilities of direct pet ownership (Crowley-Robinson, Fenwick, & Blackshaw, 1996).

Related Questions

An important question is whether the degree of attachment influences the contribution of pet ownership to health outcomes. This has intrigued many researchers, but as most longitudinal studies do not include measures of pet attachment, it has not been extensively studied. Further, currently available attachment scales are limited and applicability across species of pets has been questioned. The items often include activities commonly associated with specific types of pets, such as dog walking, and do not include activities commonly associated with birds, small mammals, and other less common species. Recently, new pet attachment measures have been developed based on attachment theory (Archer & Ireland, 2011; Meehan, Massavelli, & Pachana, 2017; Winefield, Black, & Chur-Hansen, 2008; Zilcha-Mano, Mikulincer, & Shaver, 2011; Zilcha-Mano, Mikulincer, & Shaver, 2012). Only one was validated and used in an older adult population. Age was negatively related to dog attachment in a limited cross-sectional study (Netting, Wilson, Goodie, & Stephens, 2013) and a larger sample of adults demonstrated that adults turn to their pet dogs for support and the dogs provide safe havens for their owners (Kurdek, 2009). Further, while health habits and social supports independently predicted quality of life in older adults, pet ownership and attachment to pets did not (Winefield et al., 2008). The supportive role of pets for older adults may be particularly important for older adults who are socially isolated (Krause-Parello, Tychowski, Gonzalez, & Boyd, 2012). Taken together, these findings suggest that older adults' demonstrations of attachment may differ from those of younger populations, and validation of scales across the age spectrum is a crucial step in understanding the contribution of attachment to health outcomes.

Variations in human and animal characteristics that may predict pet ownership are useful to consider as potential moderators in the contribution of pets to health. Many studies have addressed potential differences between pet owners and nonpet owners. In an early study, rates of pet ownership were lower in people living alone or with no children (Poresky & Daniels, 1998). Although in a more recent study, household social class, gender, age, household composition, presence of young children, and urban/rural area were found to predict cat and/or dog ownership (Downes, Canty, & More, 2009), no consistent patterns of dog and cat ownership predictors have emerged. As in all research, identifying additional predictors increases sample sizes needed for adequate power, thus making studies incorporating these modifiers more expensive compared with studies that include only pet ownership and/or dog ownership as predictors.

Researchers and clinicians frequently ask whether, if pets are beneficial to health outcomes, some species more beneficial than others. It is difficult to recruit sufficient owners of individual species to investigate that question, and even when the numbers are sufficient, inter-relationships of type of pet owned with other predictors of the outcome may be relevant. One study (Friedmann & Thomas, 1995) of the relationship of pet ownership to survival exemplifies this issue. Pet ownership and dog ownership were independent predictors of survival after controlling for social support and disease-related variables in coronary heart disease patients. When cat owners, defined as individuals who owned cats but no dogs, were examined separately, it appeared that they had worse survival. However, all the cat owners were women, living alone. Those two variables were strong independent predictors of survival; cat ownership did not independently contribute to prediction of survival once they were included in the analysis. So, confounding was a problem; it was impossible to separate out the contributions of cat ownership, gender, and living alone.

Contact with an Animal

Studies of short-term contact with an animal may use individuals' own pets, friendly companion animals, or trained

therapy dogs to evaluate the effect of visual, auditory, or tactile contact with an animal on some outcome. These studies are particularly useful for understanding the potential mechanisms for the contribution of HAI to various health outcomes. Their results should inform the design of both AAI and studies of the contributions of pet ownership to healthy aging. Typical short-term research designs include pre-experimental, quasi-experimental, and experimental designs, during which participants are typically exposed to some sort of interaction with an animal and their responses are evaluated. Several studies examine effects of animals as modifiers of individuals' responses to stressful stimuli, and many use biomarkers such as blood pressure or heart rate. Most are studies of children or college students, but a few include older adults. Common outcomes for the contributions of contact with an animal in older adults are of mood and social behavior, rather than moderating of stress responses.

Challenges in Studies of the Effect of Contact with an Animal

Experimental Design

Despite the strength of the causal evidence from experimental studies, several research design challenges must be considered in addition to those for observational studies. The most prominent of these is the novelty effect explanation. In the experimental situation, the person is exposed to each situation on a one-time basis, raising the question of whether participants are responding to the animal because of novelty or the unique nature of the animal itself. Although this is addressed in some AAI studies by including a familiarization period (Gee, Sherlock, Bennett, & Harris, 2009), this is not common.

Typically, experimental situations are short term and involve highly structured animal interactions. In some, participants must go to a laboratory or participate in a seemingly contrived situation that may be perceived as artificial, causing them to focus on the environment and the changes that occur during the experimental protocol. This leads to the question of whether experimental outcomes are generalizable to individuals' lives.

Experimental crossover designs in which the conditions are randomized to different orders are effective at addressing interindividual variability. The potential for carryover effects is an important aspect of designing studies that examine the impact of contact with an animal. A well-constructed Latin square design with appropriate washout periods, where outcomes are able to return to baseline prior to the next stimulus between successive conditions is a useful strategy for minimizing carryover effects.

Another important challenge for experimental studies is identifying the comparison situation. In experimental studies, outcomes are typically measured during multiple situations including both animal exposure and one or more comparison conditions. Although difficult, when possible, the comparison condition should mimic the situation with animal contact but omit the animal itself. If the situation involving animal contact includes an animal handler, the equivalent of the animal handler should be part of the comparison condition; if touching an animal is a critical component, then the comparison condition ideally will include a tactile interaction; and so on. In experimental studies, comparison conditions have included a person (Allen, Blascovich, & Mendes, 2002; Allen, Blascovich, Tomaka, & Kelsey, 1991), a robotic animal (Kramer, Friedmann, & Bernstein, 2009), a stuffed animal (Gee, Crist, & Carr, 2010; Gee, Friedmann, Stendahl, Fisk, & Coglitore, 2014), a video (Wells, 2005), and an aquarium with moving water and plants but no fish (Katcher, Friedmann, Beck, & Lynch, 1983).

In evaluating the impact of contact with an animal, it is important to consider the task/outcome combination. The tasks required during the experimental protocol may impact the response to animal contact. Contact with an animal may be beneficial during stressful social situations while the person is performing an easy task, but stressful while a person is focusing on a difficult task (Gee et al., 2014; Straatman, Hanson, Endenburg, & Mol, 1997).

Nature of Interaction Between Animal and Human

It is unclear what type of sensory exposure or interaction may affect individuals. For example, what are people's responses to tactile, visual, and auditory exposure to the animals? Do they differ depending on the species of animal and the individual's previous experiences with it? Is just watching an animal as effective as touching to achieve specific types of responses? What duration and frequency of the interaction is needed to attain specific outcomes? The type of benefit desired and the type of sensory exposure must be examined in combination in order to assess the type of contact related to specific outcomes.

The variety of ways of physically interacting with animals and the difficulty of standardizing those interactions and responses complicate experimental research. Early on, researchers recognized that people rarely interact with animals without talking to them (Katcher, Friedmann, Goodman, & Goodman, 1983). Individuals asked to touch an animal may pet it gently or vigorously; resting a hand on an animal without petting it may be stressful to one participant and relaxing to another. It is particularly difficult to evaluate the relative contributions of physical movement and exertion during interaction and the contributions of the calming influences of interaction with animals. During vigorous interaction, the arousal-moderating effects of the animal may be more than counteracted by the effects of the exertion on the outcome (Friedmann, Son, & Salem, 2015). This highlights the importance of choosing an appropriate comparison activity or situation.

The proximity or location of an animal in relation to the person is an important variable to consider in evaluating experimental research. An animal physically close to

the participant may have a different impact than an animal located several feet away. Animal species, breed, color, and size may also influence findings in relation to desired outcomes (Marx et al., 2010; Perrine & Wells, 2006; Podberscek & Serpell, 1996).

The length of the contact with the animal may also be a factor in the response. For example, sitting and watching an aquarium for a few minutes may be soothing, but being forced to do so for a long period may become stressful (Katcher et al., 1983).

Participant Characteristics

The characteristics of the person participating in a short-term study will also influence the outcomes experienced. Variables that may influence health outcomes include pet ownership history, psychosocial status, and previous experience with and attitudes toward the species, size, and/or breed of the animal involved in the study.

An individual with a prior bad experience with an animal may not respond in the same way as an individual who has had only positive experience with animals. This effect may be partially ameliorated by the research requirement that people who volunteer must be told that they may be exposed to an animal before participating in research. However, this introduces the possibility that overall positive responses may be interpreted as universal effects, rather than effects on a group selected for their willingness to be exposed to the animal. It is also important to randomly assign participants to conditions so that the representation of people who are experienced with animals and those who are less experienced with animals is similar across groups.

Animal-temperament considerations are important challenges in experimental type studies. For example, a dog that sits with a wagging tail and puts its head in the person's lap may elicit different responses, even from the same individual over time, than a dog that curls up at the person's feet and sleeps. Similarly, a child may prefer a very active dog engaged in games of fetch or raucous play, where a person of advanced years may prefer a calm dog interested in snoozing on the couch. Additionally, the two temperaments may lead to different outcomes: the first to more social interaction or lower depression (or heightened anxiety) and the second to greater feelings of calmness or lower anxiety.

There is growing awareness of the importance of the animal's response during HAI studies. Researchers are beginning to evaluate both behaviors and biomarkers as indicators of the stress experienced by animals engaged in HAI. The animal's stress level is an important consideration from perspectives of the welfare of the animal and of the person interacting with it, as high stress may result in inappropriate behavior such as biting or growling in a dog. In addition to being undesirable from an animal welfare perspective, stress in an animal is unlikely to produce the desired human health outcomes.

Finally, no matter how well designed an experimental study, there is always a chance that the demand characteristics of the study will affect the outcome. It is not possible to double blind and extremely challenging to single blind the presence of an animal. While some situations will allow deception about the focus of the study, the participant is likely to notice the presence of the animal.

Animal-Assisted Activities/Therapies/Interventions

Numerous studies have attempted to evaluate the contribution of AAIs, including AAA and AAT, for improving or maintaining health status of older adults, often addressing outcomes in populations with health conditions such as cognitive impairment or dementia. Outcomes addressed include reducing depression, agitation, and apathy and increasing social interaction, quality of life, and physical activity of the older adults (Friedmann et al., 2015; Olsen et al., 2016; Richeson, 2003; Souter & Miller, 2007).

Challenges in Evaluating the Contributions of AAIs

The most basic challenge to AAI research, beyond those previously cited, relates to the characteristics of the intervention, AAA or AAT, and the expected outcome. The identification of these two aspects go hand-in-hand. Certain outcome goals (e.g., increasing ambulation following a serious health event) can be classified as AAT because the HAI is an element incorporated into a specific rehabilitation treatment program with a specific goal. In other interventions, the HAI is not incorporated into a therapeutic program and is classified as an AAA. For example, social visits involving animals may have the potential goals of improving quality of life, bringing happiness, or increasing socialization opportunities. Specific recommendations about the design of research to test AAI may be useful to researchers (Chur–Hansen, Stern, & Winefield, 2010; Friedmann et al., 2015; Kazdin, 2011; Stern & Chur-Hansen, 2013; Wilson & Barker, 2003).

Description of AAI Activities

It is unfortunate that the actual activities that comprise the AAI and amount of time spent in each are rarely described in published intervention research, since good descriptions are crucial for interventions to be reproducible and generalizable beyond the individual setting and intervention team. The development and use of manuals for the intervention, which could be shared between research teams, is one step toward standardization of protocols used in AAIs. The evaluation of treatment fidelity (Bellg et al., 2004), which should be incorporated into all behavioral interventions, will become an important component of AAI research as the field matures to multisite studies.

Did the individual look at the animal, touch, talk, walk with the animal, or talk with the handler? Did the recipient initiate contact or interaction with the animal or handler or only interact with an animal placed in her/his lap? How much time in the total session did the recipient spend in each type of interaction? Answering these questions may require video and audio recording of session and time-consuming behavioral analyses, but these data in conjunction with outcome and basic needs data can begin to enable evaluation of the potential impact of AAIs for specific individuals.

Additional Refinements to Study Criteria/Result Analysis

Currently, there is no consensus about the value of group versus individual AAIs. In short-term studies, individual sessions are generally more effective than group sessions (Friedmann et al., 2015). Both small group AAAs and individual AATs have been found to be effective (Abate, Zucconi, & Boxer, 2011; Friedmann et al., 2015; Olsen et al., 2016), but additional research is required to identify the value of group versus individual AAA and AAT for specific outcomes.

To date, no dose-response analyses have been conducted and there are no specific recommendations for time spent in interaction or number of sessions per person or per week. These are important considerations, as there may be a threshold of total individual interaction time to achieve the best benefit for specific outcomes, but this remains to be investigated.

The trajectory of change and duration of the effect after intervention period has not been investigated for any outcome or population. This will require extended longitudinal investigation with follow-up assessments at regular intervals.

Little attention has been paid to the evaluation of individual-specific predictors of success for specific outcomes. For example, cultural and demographic characteristics, current psychosocial status, and experience with and attitudes toward animals are among the many variables that may impact the efficacy of AAI and require investigation. Research is necessary to evaluate which animals are effective for which people, under what circumstances, and what outcomes are likely to be impacted.

Most AAIs are conducted with dogs, but it is possible to use many other species; there is no evidence that one animal is more effective than another for most outcomes. In fact the variety of animals included in AAI may be surprising; in addition to dogs and cats, birds (Holcomb, Jendro, Weber, & Nahan, 1997), horses (Schultz, Remick-Barlow, & Robbins, 2007), guinea pigs (O'Haire, McKenzie, Beck, & Slaughter, 2015), goats (DeMello, 1999), rabbits (Pitheckoff, McLaughlin, & de Medeiros, 2016), fish (Barker et al., 2003), and even crickets (Ko et al., 2016) have been involved in AAIs. Obviously cultural acceptability plays a role in which animals are involved.

Variations in the Nature of Positive Results

An important consideration is the individual expected to experience the outcome from AAI. Is it the person receiving the intervention, the caregiver of the person receiving the intervention, or even the family members? What about the effects of the AAI on the animal involved? For AAI to be sustainable it is necessary to establish practices in which the animal benefits as well as the human.

The unit of analysis and research tradition used to approach the question is also an important consideration for evaluating AAIs. What is important? Is it only the biomarkers or behavior of the intervention recipient or is the recipient's perception also important? Valid studies examine recipients' or caregivers' perceptions of the effects of the interactions with an animal on the AAI recipients using qualitative traditions. Might AAI have value for the facility if not for the individual recipient? Staff outcomes both in job satisfaction and perceptions of clients/residents are also worthy of evaluation. Staff satisfaction (more content, with more positive perceptions of client/residents) is an important contributor to successful aging in any residential situation.

Research in this growing field will enable optimization of AAI frequency and duration of different types of AAI with different populations to enhance the well-being of the animals as well as the recipients. Larger samples, block randomization for important characteristics, and systematic design with attention to power will provide important additional information about outcomes that are and are not influenced by HAI and best practices to achieve specific outcomes.

Cost/benefit analysis will also be an important step in evaluating AAIs. For example, if AAT reduces time to ambulation after surgery or increases the number of steps taken, how much did the AAT cost and what costs did it save? Does it decrease the number of physical therapy sessions required for rehabilitation? Does it reduce stay in a hospital or rehabilitation facility? Does it reduce the need for aides or the need for handicap accessible transport? These are important considerations in the final evaluation of the incorporation of AAT into treatment plans and potential reimbursement for AAT by health care insurers.

Emerging Methods

The field of HAI is finally established as a bona fide scientific endeavor. Now it is time to move to systematic examination of the nuances of its contributions to healthy aging. A number of emerging methods will be helpful to investigate the role of HAIs in healthy aging.

Integrating HAI-related questions into existing large cross-sectional and longitudinal population studies will provide crucial information about the contribution of pet ownership to healthy aging. Numerous longitudinal studies already obtain considerable health data on individuals as they age. Inserting pet-ownership related questions into these studies provides an excellent opportunity to leverage the investment at additional low cost. They provide measures of numerous characteristics such as demographics, health-related behaviors, and measures of health that can be incorporated into analyses to examine mediating and moderating as well as direct relationships between pet

ownership and health outcomes. The insertion of pet ownership questions into the Health and Retirement Study and the Health A-B-C study are examples of opportunities for studying the contributions of pet ownership and walking with dogs to aging-related changes in function. The addition of these questions in combination with the large number of additional predictors and potentially confounding variables may provide a way to tease out the apparently contradictory data (Herzog, 2011) on the role of pet ownership and pet attachment in maintaining healthy aging.

A variety of technologies are available to quantify aspects of HAI. Geographic Information Systems and movement tracking devices can be used to evaluate whether pets move from room to room with their owners and the distances between people and their pets on a minute-by-minute basis; eye tracking glasses can be used to evaluate when and for how long people look at animals. Minute-by-minute recording of interactions with animals can be conducted in combination with continuous or frequent biomarker monitoring to relate the behaviors to health-related outcomes. Technology such as actigraphs, heart rate monitors, and ambulatory blood pressure monitors can provide continuous or frequent assessments. Use of these devices in real time, in which multiple outcomes and predictors/covariates are assessed simultaneously, provides a method for assessing the real-life experience of HAI and its effect on health outcomes. One recent study using ecological momentary assessment revealed that there were differences in home environment mood and cardiovascular stress markers when older adults had their pets present compared with pet absence (Friedmann, Thomas, Son, Chapa, & McCune, 2013). The study also revealed differences in the relationship of dog and cat presence to biomarkers. This emphasizes the need to simultaneously examine owners' behaviors and psychological status, pets' behaviors, and biomarkers, to provide a more complete picture of the interactions and their potential impact on healthy aging and, potentially, the pet's well-being.

Genomics and other omics may eventually provide information about the susceptibility of individuals to specific benefits or harms from HAI. Genetic variants may predispose individuals to susceptibility to certain types of stimuli—for example, anxiety responses in social situations. While no such mechanisms have been identified in people, animal models suggest this possibility. In one study of the chicken brain-specific genetic markers were related to expression of anxiety (Johnsson, Williams, Jensen, & Wright, 2016). These genes were associated but not necessarily causal for several psychiatric syndromes. Collection of genetic information to study differences in those who are responsive to AAI for specific outcomes and those who are not could be useful recommendations regarding AAT for individuals. Genetic makeup related to aging-related changes in psychosocial status may predict the contribution of HAI to health or to the impact of AAI in older adults. Inclusion of genetic analysis in studies of HAI is open to exploration of how genes are related to the effect of HAI on health outcomes.

Use of modern multivariable and multivariate statistical approaches is also crucial for analyses of data from all three groups of studies. For example, hierarchical linear modeling, latent class growth models, and propensity scores can make important contributions to the strength of findings from the complex data sets that will be created as the research encompasses more complex designs, more variables, and more complex questions. These techniques make it possible to model longitudinal correlations in outcomes, include all data in analyses even when some measures are missing for individuals, identify groups of responses and evaluate what variables predict the groups of responses, and control for the effect of predictors of pet ownership on longitudinal changes in health outcomes.

Conclusions

Once specific interventions are identified, implementation science research will be needed to develop scalable strategies to put them into practice in a wide range of facilities. Implementation studies will need to include plans for educating staff and family members, as well as assessing the needs and targeted outcomes for specific residents, matching these with appropriate AAIs, and identifying and training animals.

As in all fields, no study is ideal. The importance of the field is documented by research on HAI approached from three perspectives, (a) health effects of pet ownership; (b) health effects of contact with a companion animal; or (c) health effects of AAIs. The existing research justifies further investigations to more completely understand how best to take strategic advantage of benefits of HAI for both people and animals and to minimize unproductive use of human and animal resources. This paper brings attention to details of studies and presents some opportunities that are critical for implementing the high quality, rigorous studies needed to achieve this goal.

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Conflict of Interest

None reported.

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